power of producing nuclei when cold, while others, as aluminum, had little effect. Experiments with ordinary air and with the pure air found in the neighborhood of Loch Awe both showed that whereas large nuclei were present, small nuclei requiring more than a 6 per cent expansion to produce condensation were generally absent. This did not support the theory that nuclei are aggregations of ions, since in this case nuclei of all sizes from that of a single ion upward would be expected. Some tests were made with air ionized by means of radium salts, but even after long intervals extending up to a day no tendency was observed for the ions to combine and produce large nuclei. It is therefore considered as proved that the "large ions of the atmosphere" are in reality nuclei to which an ion has become attached and given up its charge. The paper contains much detail information which can not be summarized in an abstract.—*J. S. Di[nes]*.

RELATION BETWEEN SUNLIGHT AND MOONLIGHT.[1]

By J. S. Dow.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §931.]

Taking sunslight to be equivalent to 10,000 candle-feet (for perpendicular incidence from an unclouded sky), the corresponding illumination from the full moon is calculated to be 0.02 candle-foot. The author finds this to be very near the value he obtained by actual measurement. The range of illumination between sunlight and moonlight is thus of the order of 1 to 500,000.—*C. P. B[utler]*.

[See this REVIEW for June, 1914, p. 347 for another estimate of the moon's brightness.]

551.5/c.5 (c48)

MINUTE STRUCTURE OF THE SOLAR ATMOSPHERE.[2]

By G. E. HALE & F. ELLERMAN.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §873.]

A short summary is given of the result of an extensive investigation of spectroheliograms showing the structure of the solar atmosphere at various levels in comparison with that of the low-lying photosphere and sunspots. For the photosphere Langley's "rice grains" and "granules" are still the best standards for denoting the minute structure, the granules being about 0.3 second in diameter (say about 130 miles). Photographs taken with the spectroheliograph in calcium light can be made to show details at different levels according to the slit setting. The smallest calcium flocculi observed are less than 1 second in diameter. In the case of the highest levels shown by the dark hydrogen flocculi in Hα-light, the smallest flocculi are about 2 seconds in diameter. This seems to support the view that the photosphere and gaseous atmosphere above it are formed of columns of hot gases, rising by convection from the interior of the sun. To illustrates these difference of level a stereoscopic picture is given of a dark hydrogen flocculus floating over the region of a large spot group on 1915, August 7, the vortex action of the spots is also well shown by the bending of the hydrogen flocculus near the spot umbræ. It is concluded that the minute structure of the quiescent solar atmosphere resembles that of the photosphere. In disturbed regions, the small granular regions are replaced by slender filaments, lying side by side, resembling the structure of penumbræ of sunspots.—*C. P. B[utler]*.

The present editor reprints below the last paragraph of the original proceedings of the National Academy of Sciences, February, 1916, **2**:108:

> We have shown in this paper that the minute structure of the quiescent solar atmosphere resembles that of the photosphere. In disturbed regions, the small granular elements (minute flocculi) are replaced by numerous slender filaments, lying side by side, and recalling the structure of the penumbra in sun spots. While these results appear to support the hypothesis that the solar atmosphere consists of parallel columns of ascending and expanding gases, which are drawn out horizontally in spot penumbræ and in disturbed regions of the chromosphere, such questions as the dimensions of the columns and the direction of motion and velocity of the vapor in sun spots and in the atmosphere about them are reserved for subsequent discussion.

523.4 (048)

WHY THE AXES OF THE PLANETS ARE INCLINED.

By Prof. WILLIAM H. PICKERING

(Harvard College Observatory, Mandeville, Jamaica, B. W. I.)

[*Reprinted from* Popular Astronomy, October, 1917, 25.]

[The intimate relation existing between the climates and meteorology of a planet and the inclination of its axis to the plane of the ecliptic, seems sufficient justification for introducing this astronomical discussion here—C. A., jr.]

This question is constantly asked by students of astronomy, and the answer generally given is either that it "just happened so," or else that "nobody knows." In point of fact the answer is not very far to seek. Imagine a large revolving gaseous mass condensed toward the center. Recent observations seem to show that at least one of the nebulæ revolves as one piece, as if it were a solid body, but in general there is no question but that in a loosely formed gaseous mass the outer portions will travel at a lower linear rate than the inner ones. Let figure 1 represent such a condensing gaseous mass, with a huge condensation at *a* and a relatively small one beginning to form at *b*. The shape of the latter is of no consequence, whether it is spherical from the beginning, or merely the portion of an arm of a spiral. In either case its outer portion revolves about *a* more slowly than its inner, as is indicated by the arrows, and if it finally condenses sufficiently to form an independent body, revolving about *a* in a positive direction, its rotation on its own axis will be *negative*, or as we usually describe it *retrograde*.

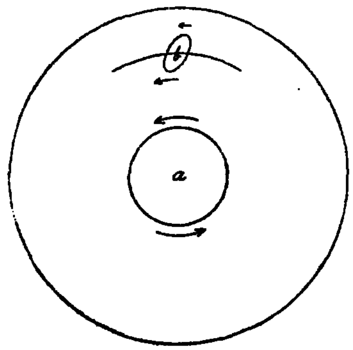

FIG. 1.—Illustrating the origin of the initially retrograde rotation of a satellite or a planet, *b*.

If this is the method by which the planets were formed, which seems not unlikely, why is it then that their rotation is found to be direct instead of retrograde? In point of fact the rotation of the two outermost *is* retrograde as has been known theoretically, from the direction of revolution of their satellites, for many years. Only recently this direction has been confirmed spectroscopically for Uranus at the Lowell Observatory (Lowell Observatory Bulletin No. 53) and the period of rotation found, $10^h 50^m$. This period has been confirmed,

[1] Illum. engr., London, April, 1917, 10: 113-114.
[2] Proc., Nat. acad. sci., February, 1916, 2: 102-108.